RESEARCH PAPER

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A pilot study on the effects of individually tailored education for MMR vaccine-hesitant parents on MMR vaccination intention

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Abbreviations: MMR, measles-mumps-rubella; VPDs, vaccine preventable diseases; VIS, Vaccine information sheet; UMHS, University of Michigan Health System

Healthcare providers need strategies to better address the concerns of vaccine-hesitant parents. We studied whether individually tailored education was more effective than untailored education at improving vaccination intention among MMR vaccine-hesitant parents. In an intervention pilot study of parents (n = 77) of children < 6 y who screened as hesitant to vaccinate against MMR (first or second dose), parents were randomly assigned to receive either (1) educational web pages that were individually tailored to address their specific vaccine concerns; or (2) web pages similar in appearance to the intervention but containing untailored information. The main outcome, change in vaccination intention before and after the intervention, was assessed using an 11-pt scale (higher values indicated greater intent). We found that a greater proportion of parents in the tailored than untailored arm had positive vaccination intentions after viewing educational information (58% vs. 46%). Furthermore, parents in the tailored group had a greater magnitude of change in vaccination intention (1.08 vs. 0.49 points) than participants in the untailored group. However, neither of these results was statistically significant. From this pilot study we conclude message tailoring may be an effective way to improve vaccine compliance among vaccine hesitant parents. However, larger studies are warranted to further investigate the efficacy of providing tailored education for increasing vaccine acceptance among parents with diverse beliefs.

Introduction

Due to the success of vaccination programs, parents of young children in the United States typically do not have personal experience with vaccine preventable diseases (VPDs).[1] As a result, an increasing number of parents perceive the potential safety and health risks of vaccinations to be greater than the risks associated with VPDs.[2-7] As of 2009, approximately one in 8 US parents reported having refused at least one vaccine for their children and thus could be defined as "vaccine-hesitant."[8]

The measles, mumps and rubella (MMR) vaccine is frequently questioned by parents regarding its safety and necessity.[8-11] In 2008, Gust et al. found that 37% of mothers of young children nationally had concerns about MMR vaccines.[11] Multiple barriers to MMR vaccination have been identified, including concerns about vaccine side effects (80%), personal knowledge of someone harmed by the vaccine (40%), and perceived low risk for the diseases prevented by the vaccine (36%).[8] Even though coverage with MMR vaccine is high nationally (state-specific median 94.8% for two doses of the vaccine by kindergarten),[12] there have been community outbreaks of measles and mumps throughout the US, particularly among unvaccinated populations.[13-16] Over time the number of parents exempting children from one or more recommended vaccines has risen considerably.[12]

To counteract the increasing parental indecision about recommended childhood vaccines, healthcare providers need strategies that successfully communicate vaccine-related information. An extensive body of research has demonstrated that message tailoring (i.e., providing messages that address each individual's specific concerns, beliefs and experiences) is an effective method for increasing compliance with preventive health behaviors, but to our knowledge has never been applied to parental MMR vaccine hesitancy[17-20] (though some studies suggest a potential role for message framing and/or decision aids in positively influencing parental MMR vaccine decisions,[21,22] and formative studies suggest a benefit to offering different types of educational materials depending on the degree of parental vaccine hesitancy).[23,24] We tested whether an individually-tailored web-based intervention was more effective than a similar-appearing untailored intervention at improving parental MMR vaccination intention among MMR vaccine-hesitant parents.

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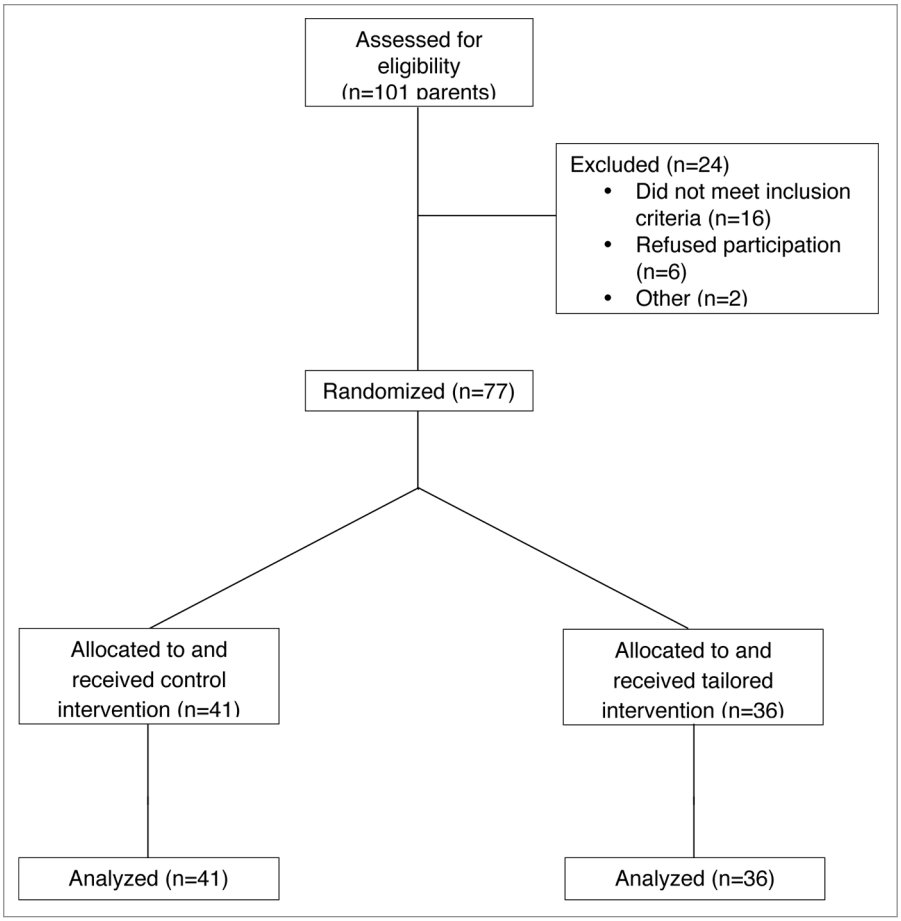

Figure 1. Participant flow through the randomized trial.

Results

A total of 79 participants were enrolled between June and December 2011, of which 77 were randomly assigned to either untailored (n = 41) or tailored (n = 36) information (**Fig. 1**). *Complete* web utilization data was available for 75 participants. There were no statistically significant differences in the sociodemographic characteristics between the two groups (**Table 1**). Approximately 50% of parents in the sample overall (n = 40) indicated that they had refused at least one recommended vaccine for their child in the past (data on which specific vaccine was refused was not collected), but there was no difference between study arms in this characteristic. Of the 36 parents with children less than 1 y of age (who could therefore only be considering the first MMR vaccine recommended), 36% (n = 9) indicated that they had refused a recommended vaccine for their child in the past. This condition was also balanced between arms.

Although all parents screened positive for MMR vaccine-hesitancy at the initial eligibility assessment (described below), 34% reported that they would consider having their children get the MMR vaccine if recommended by their children's physicians in their baseline assessment of vaccination intention (**Table 1**). As per our protocol, these parents were included in the main intention-to-treat analysis. However, as a secondary analysis, we also assessed our main outcome measures with parents stratified by their baseline vaccination intentions.

Intervention effects. Viewing either tailored or untailored education resulted in a statistically significant increase in the proportion of parents who intended to vaccinate their children against MMR (from 34% to 52% among the study population overall; **Table 2**). However, this effect appeared more pronounced for the tailored education group than the untailored group (**Table 3**), although the difference was not statically significant. When stratified by baseline vaccination intentions, we found that the majority of increased vaccination intent resulted from parents moving out of the "unsure/neutral category" as 10 of 21 participants (48%) changed from neutral to positive intentions in the control group while 8 of 14 parents (57%) did so in the intervention group (**Table 4**).

When intentional change was assessed using a linear measure (see methods for description) we also found larger differences in this outcome among the tailored compared with the untailored group (1.08 vs. 0.49 points, p = 0.22), but this result was not statistically significant. When stratified by baseline vaccination intentions, parents who had negative or neutral intentions had greater linear intentional change than parents with baseline positive intentions. These differences were not statistically significant (**Table 5**).

When examined at an individual level, our results may suggest that viewing untailored information results in a higher likelihood of worsening parental intentions for the MMR vaccine when compared with tailored education. Of the 14 parents in the untailored group with baseline positive vaccination intentions, 3 and 2 parents moved to negative or neutral intentions, respectively, after viewing the intervention (**Table 4**). In addition, these parents were the only subgroup to have a net decrease in linear intentional change (-0.79 points, **Table 5**). In contrast, none of the parents in the tailored arm with baseline positive intentions changed categories. However, 2 of 14 parents who had baseline neutral intentions in the tailored group reported negative intentions post-intervention (**Table 4**), although the mean linear intention change in this group was still positive (1.14 points, **Table 5**).

Process measures. Parents receiving untailored information accessed an average of 5 (range 1–7) of the 7 web pages available while parents receiving tailored information accessed an average of 7 (range 1–15) of the 27 available web pages. The most frequently visited webpage by the untailored group discussed the possible side effects of the MMR vaccine, whereas in the tailored group it was the page on whether the "MMR vaccine was safe or not."

Table 1. Baseline characteristics of study population (n = 77)[a]

Socio-demographic characteristic	Untailored intervention % (n)	Tailored intervention % (n)
Total Sample	53% (41)	47% (36)
Parent's age		
≤ 24 y	17% (7)	14% (5)
25 to 34 y	49% (20)	50% (18)
35 to 44 y	27% (11)	30% (11)
46 to 55 y	7% (3)	6% (2)
Child's age		
0 to 12 mo	54% (22)	39% (14)
13 to 23 mo	12% (5)	6% (2)
2 to 3 y	17% (7)	19% (7)
4 to < 6 y	17% (7)	36% (13)
Child's gender (Female)	52% (21)	53% (19)
Race/ethnicity		
African-American	10% (4)	33% (12)
Hispanic	10% (4)	8% (3)
Caucasian	73% (30)	50% (18)
Other	7% (3)	8% (3)
Baseline vaccination intention	% (n)	% (n)
Plan to get MMR vaccine, categorical measure[b]:		
Negative	15% (6)	28% (10)
Unsure/neutral	51% (21)	39% (14)
Positive	34% (14)	33% (12)
	Mean (SD)	Mean (SD)
Plan to get MMR vaccine, linear measure[c]:	5.34 (1.98)	5.06 (2.59)

Abbreviations: MMR, measles-mumps-rubella. [a]There were no statistically significant differences in socio-demographic characteristics or baseline vaccination intention between intervention groups. [b]Participants were divided into three mutually exclusive categories based on their responses to the statement, "I plan to have my child get the MMR vaccine [at the recommended ages] if recommended by my child's doctor." Responses followed an 11-point scale, where higher values corresponded to greater agreement with the statement. Parents who responded with a score ≤ 4 were classified as having "negative vaccination intention," score of 5 indicated "unsure/neutral intention," and a score > 5 represented "positive vaccination intention." [c]Vaccination intention was also defined as a continuous variable based on participants' responses using the same 11-point scale described above.

Table 2. Comparison of change in parental vaccination intention from baseline to post-intervention within each intervention group

Within-group comparison	Untailored intervention (n = 41)			Tailored intervention (n = 36)		
Baseline intentions for child get MMR vaccine*:	Baseline vaccination intention % (n)	Post-intervention vaccination intention % (n)	P-value	Baseline vaccination intention % (n)	Post-intervention vaccination intention % (n)	P-value
Negative	15% (6)	20% (8)		28% (10)	19% (7)	
Unsure/Neutral	51% (21)	34% (14)	0.01	39% (14)	22% (8)	0.001
Positive	34% (14)	46% (19)		33% (12)	58% (21)	

Abbreviations: MMR, measles-mumps-rubella. *Participants were divided into three mutually exclusive categories based on their responses to the statement, "I plan to have my child get the MMR vaccine [at the recommended ages] if recommended by my child's doctor." Responses followed an 11-point scale, where higher values corresponded to greater agreement with the statement. Parents who responded with a score ≤ 4 were classified as having "negative vaccination intention," score of 5 indicated "unsure/neutral intention," and a score > 5 represented "positive vaccination intention."

Parents receiving untailored information spent less time overall on the website than those receiving the tailored information (141 vs. 221 sec, p = 0.015). However, the *average* time spent per web page was similar for both groups (29 and 25 sec for untailored and tailored arms, respectively, p = 0.43). Although nearly 50% of participants in the untailored group (n = 19) viewed all 7 unique web pages, there were 8 participants (21%) who viewed only the introductory page. None of the parents in the tailored group viewed all 27 of the available web pages, and 5 participants (14%) viewed only the introductory page.

Discussion

There is a great need to find strategies to counteract the growing problem of vaccine-hesitancy among US parents.[3-7] While receipt of both untailored and tailored educational web-based

Table 3. Comparison of change in parental vaccination intention from baseline to post-intervention between intervention groups

Between-group comparison	Baseline vaccination intention			Post-intervention vaccination intention		
Baseline intentions for child get MMR vaccine*:	Untailored Intervention % (n)	Tailored Intervention % (n)	P-value	Untailored Intervention % (n)	Tailored Intervention % (n)	P-value
Negative	15% (6)	28% (10)		20% (8)	19% (7)	
Unsure/Neutral	51% (21)	39% (14)	0.327	34% (14)	22% (8)	0.476
Positive	34% (14)	33% (12)		46% (19)	58% (21)	

Abbreviations: MMR, measles-mumps-rubella. *Participants were divided into three mutually exclusive categories based on their responses to the statement, "I plan to have my child get the MMR vaccine [at the recommended ages] if recommended by my child's doctor." Responses followed an 11-point scale, where higher values corresponded to greater agreement with the statement. Parents who responded with a score ≤ 4 were classified as having "negative vaccination intention," score of 5 indicated "unsure/neutral intention," and a score > 5 represented "positive vaccination intention."

Table 4. Number in individuals in the study population who changed vaccination intention categories from before and after the intervention

Untailored Intervention (n = 41): Intentions for child get MMR vaccine*:	Post-intervention vaccination intention (n)		
Baseline vaccination intention (n)	Negative	Unsure/Neutral	Positive
Negative	5	1	0
Unsure/Neutral	0	11	10
Positive	3	2	9
Tailored Intervention Arm (n = 36): Intentions for child get MMR vaccine*:	**Post-intervention vaccination intention (n)**		
Baseline vaccination intention	Negative	Unsure/Neutral	Positive
Negative	5	4	1
Unsure/Neutral	2	4	8
Positive	0	0	12

Abbreviations: MMR, measles-mumps-rubella. *Participants were divided into three mutually exclusive categories based on their responses to the statement, "I plan to have my child get the MMR vaccine [at the recommended ages] if recommended by my child's doctor." Responses followed an 11-point scale, where higher values corresponded to greater agreement with the statement. Parents who responded with a score ≤ 4 were classified as having "negative vaccination intention," score of 5 indicated "unsure/neutral intention," and a score > 5 represented "positive vaccination intention."

interventions in our study resulted in statistically significant increases in the proportions of parents willing to vaccinate their children against MMR, results of our pilot study suggest that this effect is potentially greater among the group receiving tailored information. This is supported by the finding that a greater proportion of parents receiving the tailored intervention reported positive MMR vaccination intentions after the intervention than parents receiving untailored information (58% vs. 46%) and that parents who received tailored education had a higher magnitude of change in vaccination intention (1.08 points) compared with those who received untailored information (0.49 points).

Although these results are promising, our pilot study's sample size was too small for these differences to reach statistical significance. A larger sample size than what was included in our pilot study would be needed to definitively conclude that tailored information is superior to untailored information for improving vaccination intention. Specifically, we would need to have recruited approximately 250 parents in each study arm to identify as statistically significant the 0.5-point difference in the change in linear vaccination intention or the 12% difference in the proportion of parents with positive vaccination intention (defined categorically) found between experimental groups. To our knowledge, ours is the first study to examine the impact of message tailoring on vaccination intention. Because of this, we had to "guesstimate" the effect size our intervention might have. Based on the results of our study, it appears that our presumed 2-point increase in vaccination intentional change (which formed the basis of our sample size calculation) resulting from the intervention was likely overly optimistic. In our ongoing research exploring the role of message tailoring on vaccination intention and compliance we have taken a much more conservative approach to sample size estimation. The larger sample size of our ongoing studies will be more able to definitively address whether tailored education is superior to untailored education for improving vaccination intention (and will also assess the impact of message tailoring on vaccine receipt). This is particularly important since we found statistically significant increases in vaccination intention even among those receiving the untailored information. Despite these limitations, our results are in keeping with a significant body of literature that supports the benefit of using tailored, rather than untailored, information to improve compliance with preventive health behaviors.[25-27] Further study is needed to understand the most important elements and "dose" of message tailoring that is effective for increasing immunization, and whether the efforts to do this type of tailoring are worth the "costs" associated with this type of intervention.

Table 5. Linear intentional change* from before and after the study intervention

Linear intentional change	Untailored intervention (n = 41)	Tailored intervention (n = 36)	P-value
All participants: Mean (SD)	0.49 (2.39)	1.08 (1.68)	0.22
Categorized by baseline vaccination intention			
Negative: Mean (SD)	0.83 (1.72)	1.5 (1.90)	0.49
Unsure/Neutral: Mean (SD)	1.24 (1.61)	1.14 (1.99)	0.88
Positive: Mean (SD)	-0.79 (3.12)	0.67 (0.98)	0.14

Abbreviations: MMR, measles-mumps-rubella. *Linear intentional change was defined as the difference between the post-intervention and baseline vaccination intention scores (measured as a continuous variable with a scale of 0 to 10) for each participant. Higher numbers on the 11-point scale corresponded to greater vaccination intention.

Overall, approximately 40% of parents changed their vaccination intention (31% toward more positive intentions) after reviewing the interventions, indicating that these parents' vaccine hesitancy may be related to a lack of adequate information to make a decision. This is further supported by the overall reduction in the proportion of parents who were "unsure/neutral" about the vaccine post-intervention. Whereas 51% and 39% of parents in the untailored and tailored groups, respectively, reported baseline "unsure/neutral" vaccination intention, 27% and 11% respectively remained neutral after viewing the educational messages. Thus, educational interventions (perhaps even untailored) can play an important role in promoting positive vaccination beliefs among a population that reports initial vaccine hesitancy.

Our pilot study may suggest that untailored information might have a detrimental effect on some parents' vaccination intentions. However, this possible conclusion warrants further study as the sample size in which this occurred (n = 5) was small. Specifically, though we found that most parents had improved vaccination intention after viewing the interventions, this was not true for five parents (out of 41) in the untailored group with baseline positive vaccination intentions. If larger studies do indeed support this finding further, this could have significant implications for clinical practice since it would suggest that the VISs that are currently provided as the "standard of care" may have unintended, potentially harmful consequences. Previous studies demonstrate that mentioning vaccine-related risks without describing these more fully in a thorough risk-benefit discussion can lead to increased hesitancy toward vaccination,[28] and that vaccine-hesitant parents often perceive the information provided by health professionals to be potentially biased and incomplete.[29-31] By making the information more relevant to each individual's specific concerns and beliefs (even if erroneous),[32] message tailoring may be able to effectively overcome these barriers. Exploring potential detrimental effects of untailored information on parental vaccination intention is a focus of our future research efforts.

Another limitation of our study was the specificity of the sample recruited to the intervention. Although all parents in our study screened "positive" for MMR vaccine-hesitancy using our single-item eligibility question prior to the start of the study, a surprisingly high percentage (34%) had positive vaccination intentions when measured at baseline. This finding has two important implications for our results. First, it suggests that our screening question was not specific enough to accurately identify the subgroup of parents with vaccine-hesitancy that was sufficiently strong so as to actually refuse the vaccine for their child, pointing to a need for better tools to identify these parents. The Parents Attitudes about Childhood Vaccines survey[33,34] holds promise in this regard, though unfortunately it was unavailable at the time of our study's recruitment. Second, because of our intention-to-treat analysis, parents with positive vaccination attitudes were included in the main analyses, which may have diminished the observed impact of the tailored intervention and may explain why our main results failed to reach statistical significance. A larger, more specific sample would be preferable for future studies. However, the fact that we still found a pattern of increased efficacy of the tailored intervention over the untailored one, even with the inclusion of parents with baseline positive intentions, suggests that the actual effect size of the tailored intervention may be substantially larger than what we were able to demonstrate.

We found important similarities in how parents in both groups navigated the educational web pages that will help inform the design of future web-based interventions. All participants spent approximately 30 sec viewing each web page, which addressed a specific concern about the MMR vaccine, suggesting that this is the average length of time that a parent may be willing to spend reading any one topic. Interestingly, parents who received the tailored education viewed on average a lower proportion (7 of 27) of the web pages available to them than parents in the control group (average of 5 of 7 web pages). This finding suggests that simply providing a greater amount of information is not likely to improve parental awareness or ultimately vaccination behavior. Instead, it would appear that an effective educational program needs to ensure that it presents the most highly relevant information for that individual. This concept is in keeping with tailoring theory,[37] and is further supported by our analysis of the order in which webpages were viewed. Parents viewing tailored messages appeared to independently select the order in which to view web pages, whereas most parents in the untailored group viewed web pages sequentially. Maneuvering around the intervention to view only the web pages of personal interest is another (self-imposed) mechanism of tailoring that would allow participants to obtain more relevant information in less time than with the untailored intervention. This is of particular significance since our study showed that parents are not likely to view all of the educational information presented, and actually spend relatively short amounts of time reviewing each topic.

Limitations. In addition to the limitations described above (small sample size and inclusion of parents with baseline positive

intentions in the analysis), other limitations should be noted. Our study was originally powered to detect a 2-point difference in linear intentional change. However, our intervention only resulted in a 1-point change in this measure, and a difference of only ~0.5 points in this measure between experimental groups. In addition, the control group received information from the VIS sheets in a novel way (i.e., as web-pages), which in itself is an intervention that differs from the standard of care where paper-based VIS handouts are distributed. This was done purposefully so as to isolate the effects specifically from message tailoring, but may have led us to underestimate the impact of our tailored intervention compared with the standard of care. Moreover, our pilot study enrolled parents from one geographic area of Michigan and focused on one vaccine, limiting the generalizability of our findings. In this initial pilot, we studied change in vaccination intention, which is positively associated but not synonymous with vaccine utilization.[35,36] Future studies are needed to examine whether any observed changes in vaccination intention between tailored and untailored groups result in significant differences in actual vaccine utilization.

Patients and Methods

Study population. We performed a randomized intervention pilot study of parents, guardians or primary caretakers (i.e., "parents") of children < 6 y who were hesitant to vaccinate against MMR (either first or second dose). Parents were eligible if they were ≥ 18 y old, able to read/converse in English and were screened as MMR vaccine-hesitant using a broad measure of vaccine hesitancy that would capture the full spectrum of such parents.[11] Specifically, parents answering that they "did not want" or "were unsure" (as opposed to "did want") about getting the MMR vaccine for their child at the recommended ages after reading the statement "The MMR vaccine is recommended for all children at ages 12 to 15 months and again at ages four to six years," were categorized as MMR vaccine-hesitant and considered eligible for participation.

Our study sample consisted of a convenience sample of eligible parents that were recruited by a research assistant from the waiting rooms of the 9 pediatric primary care clinics affiliated with the University of Michigan Health System (UMHS), or via the University's clinical trial recruitment website. Randomization occurred at the time of consent. Participants completed the study in clinic waiting rooms or at the coordinator's research office. All participants were provided with computer and Internet access and received a $40 gift card as compensation. Study procedures were approved by the UMHS Institutional Review Board. This study was registered under the National Institutes of Health ClinicalTrials.gov database (study identifier NCT01369394).

Study intervention. After randomization, participants first completed a computer-based survey that assessed socio-demographic characteristics, prior experience with the MMR vaccine, attitudes toward vaccination, and baseline vaccination intention (described below). Subsequently, a computer algorithm randomly assigned parents to receive either tailored or untailored education. Investigators were blinded to group assignment, and parents were unaware that they were participating in a study on the effectiveness of message tailoring.

For those in the tailored arm, an internal "tailoring engine" accessed each parent's information from the baseline survey, and used this information to generate individually tailored web pages. Consistent with typical tailoring methodologies,[32,37] the web pages were tailored on four levels: (1) Image tailoring provided pictures of families on some of the pages that matched the self-reported race of the parent; (2) Content tailoring occurred at the paragraph level whereby each parent's survey responses were used to derive a set of informational messages addressing his/her specific concerns; (3) Experiential tailoring whereby parents' past experiences (e.g., knowing someone harmed by the vaccine; refusing other vaccines) were reflected at the sentence level in the information provided; and (4) name tailoring that occurred at the sentence level by incorporating the child's name directly into the message content throughout the text (examples of each level of tailoring provided in **Figure 2**). Tailoring occurred in "real time" meaning that there was no delay to "build" the webpages between the time the parent completed the survey and when they viewed the educational information.

The untailored group viewed web pages similar in appearance to the intervention but containing untailored information derived directly from the MMR Vaccine Information Statement (VIS) developed by the Centers for Disease Control and Prevention (**Fig. 2**). VIS sheets are required to be provided prior to vaccine administration[38] and are recognized as the "standard of care" with regard to vaccine education.[39] In both experimental groups, participants could navigate through the web pages at their own pace and in any order. After viewing the educational information, MMR vaccination intention was reassessed using the same measure as at baseline.

Outcome measures. The primary outcome of interest was the change in MMR vaccination intention from before to after viewing the intervention. This was assessed using an 11-point scale, but two analytic approaches. In the first, parents were classified into three mutually exclusive categories of vaccination intention depending on their responses to the question, "I plan to have my child get the MMR vaccine (at the recommended ages) if my child's doctor recommends it" ("negative intention" if ≤ 4, "neutral/unsure" if 5, and "positive intention" if > 5). The proportion of participants changing vaccination intention categories from before and after receipt of the intervention (i.e., "categorical intentional change") was assessed. We aimed to recruit a study population of 80 parents (n = 40 in each experimental group), which would provide sufficient power to detect a 30% difference in the proportions of parents in each vaccination intention category (β – 0.8, two-sided α – 0.05) between study groups.

In the second approach, the 11-point scale assessed parental vaccination intention as a continuous measure. This was done because: (1) Previous studies of parental vaccination intentions have used this 11-point scale[40,41] facilitating comparison of our results to other studies; and (2) a linear scale allows for the magnitude of change to be assessed more directly. The difference in vaccination intention "scores" from before and after viewing

Figure 2. (**A**) is a screen shot of a web page discussion MMR vaccine safety viewed by a parent in the intervention group while (**B**) is the web pate discussing MMR vaccine safety shown to all parents in the control group. The menu on the left in Panel A is tailored to highlight the most important concerns identified by that parent, while all parents in the control group received the standard menu shown in (**B**). Both parents from the examples were Asian-American mothers between 25–34 y old with a male child age 11–15 mo. All parents first read an introductory page about the study and proceeded to the survey, then viewed either tailored or untailored vaccine information before completing the post-survey questions (see tabs at the top of both screens). The different levels of tailored used in the intervention are shown in (**A**). green, name tailoring; blue, content tailoring; red, image tailoring; purple, experiential tailoring.

the intervention ("linear intentional change") was calculated for each participant. Our goal recruitment number (n = 80) provided power to detect a 2-point difference in linear intentional change between groups (β–0.8, two-sided α–0.05). Though a linear scale has been used in previous studies of parental vaccine intentions,[40,41] studies remain ongoing to determine the correlation

between changes in this scale and clinical outcomes. When estimating the needed sample size, the intervention effect was hypothesized to result in a 2-point difference in linear intentional change, as this was felt by the study investigators to be the smallest change in vaccination intention that could result in clinically meaningful differences in vaccination behaviors.

Process measures. We examined differences in the utilization of the web pages between the study groups. The number of web pages accessed, the order of viewing, and the average time spent per web page and on the intervention overall were calculated for each participant.

Analyses. As per the CONSORT group guidelines,[42] an intention-to-treat approach was undertaken and all available data were incorporated. Descriptive statistics were generated for the outcome measures as well as for the potential predictor variables and process measures. Within-group intervention effects on categorical intention change were determined using exact symmetry tests. The effects of group assignment on categorical intention change and mean linear intentional change were assessed using chi-square tests and paired student t-tests, respectively. P-values ≤ 0.05 were considered statistically significant. All analyses were performed using STATA 12.0 (StataCorp).

Conclusions

We found that MMR-vaccine hesitant parents reported greater vaccination intent after using an educational web-based intervention, and that this effect was more pronounced when the material provided was individually tailored. While we did not find statistically significant differences in the effectiveness of individually-tailored education compared with untailored information, we believe that this may be due to under-powering of our study given that all measures of vaccination intention were better among the group receiving the tailored materials. The variation in baseline vaccination intentions among our study population indicates that the vaccine-hesitant parent population is truly a heterogeneous group, and that educational interventions should develop mechanisms to meet the subgroups' differing informational needs. The efficacy of providing tailored education for increasing vaccine acceptance and utilization warrants further investigation among larger samples of parents with diverse beliefs and backgrounds.

Disclosure of Potential Conflicts of Interest

Since June 2009 Amanda Dempsey has served as an advisory board member for Merck, providing advice on HPV vaccination. Since 2012 Amanda Dempsey has served on an advisory board for Pfizer providing advice about meningococcal vaccination. Neither of these companies had a role in the design or analysis of this study, and are unaware of the study's results. Dr. Dempsey does not receive research support from either company. The remaining authors have no conflicts to declare.

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